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Method for carrying out a blind handover in an intersystem and interfrequency handover in mobile communication systems

The invention relates to a method for carrying out a so-called 'blind handover' in an intersystem and interfrequency handover in mobile communication systems, in particular in inhomogeneous network structures of the participating mobile communication systems.

In the case of inhomogeneity of the different network structures, i.e. different frequency positions or coverage areas of the participating networks, no ensurance for the successful completion of the HO can be given in a so-called blind handover (HO).

The specification currently in effect provides that, for example, in a handover between a UMTS layer and a GSM layer, per UMTS cell, one HO candidate for a blind handover can be configured. In this case it is assumed that the coverage area of the target cell agrees with the source cell. Stated differently, the coverage area of the particular cell of the UMTS and of the GSM network are congruent at the site of the handover. Otherwise the resulting situation is ambiguous. The consequence would be an HO error and therewith the risk of losing the connection (call drop).

To avoid these problems in a blind handover, so-called dual mobile subscriber terminal sets, i.e. mobile telephones with two separate transmitting/receiving devices can be utilized, which are capable of operating simultaneously at two frequencies or in two mobile networks.

The signaling between subscriber terminal set and the participating network nodes, such as for example base stations, RNC (Radio Network Controller) and the mobile switching centers (UMSC) of the participating mobile communication networks, exchanged during a handover, is not subject matter of the method

described here. It is therefore not further discussed in the following.

The invention aims to specify a method with which even blind handovers can be carried out without high risks between the different layers of mobile communication systems, even if these do not have a common network structure.

This aim is attained according to the invention through the characteristics of patent claim 1.

The invention builds on the fact that, before the handover, a mobile station is supplied from several base stations. This means that, apart from the supplying base station, it can also receive signals from several other base stations.

According to the invention a propagation time measurement is carried out at the air interface by the mobile station of the signals received from the base stations.

The measured propagation times are transmitted to one of the base stations.

Thereupon, on the basis of the transmitted propagation time measurement data, the mobile communication network determines the [temporary] residence site of the mobile station. With the aid of a data base subsequently on the basis of the determined residence site at least one suitable base station for an intersystem or interfrequency handover is selected, and the data of the selected base station, required for a handover, are transmitted to the mobile station. In conjunction with this information the mobile station can carry out the handover to the selected base station.

With this method the capability is given of unerringly carrying out such HOs with a further developed blind handover, also referred to in the following as blind handover advanced.

The described method leads to important advantages:

- In the so-called UMTS compressed mode, requisite HO measurements must be initiated, which, depending on the situation and number of HO

candidates, make several GAPs (General Access Profile) necessary. In a blind handover according to the invention no time is lost.

- Through the mechanism of the Compressed Mode (CM), additional interference is generated in the network. In turn, this means a reduction of capacity. In contrast, through the described method an increase of capacity is attained, since no CM is necessary.
- Through the method, other mobile communication services, which require place of location information of the subscriber, can be implemented without major additional engineering efforts.
- The method functions within as well as also outside of buildings without additional GPS.
- The terminal sets do not need to be equipped with GPS or be implemented as dual terminal sets (with two transmitting/receiving units) and therefore can be produced more cost-effectively.

Advantageous embodiments and further developments of the invention are evident based on the characteristics of the dependent claims.

To determine the site information the subscriber terminal set must measure the [signal] level conditions in its own cell and at least in one or two further cells. In addition to the signal levels, the signal propagation times at the air interface are also measured. Should this actually not be required, due to the current level conditions of the supplying cell, the terminal set by necessity has to be requested to carry out this measurement. This can, for example, be performed thereby that to the terminal set specifically other supply level threshold values are transmitted which compel a measurement or that the parameter of the network are set at the outset such that performance of these measurements becomes mandatory.

The information of the signal propagation times generated in this manner is transmitted to the network. To be able to utilize this information for a blind handover, the layer in which the potential target cell is located must previously be analyzed for the base station providing the best supply, thus the best server has to be determined. This can be carried out in different ways. For one, the coverage area of the best server can be determined with appropriate methods and, for another, this can be done from available measuring data. The best servers determined in this manner can be assigned at each point via [the geometry of] the polygon.

The coordinates of the terminal set are subsequently compared with the best server data base and in this way the appropriate target cell is selected. This target cell is subsequently transmitted through an HO command to the terminal set and therewith the blind handover advanced is specifically completed.

An embodiment example of the invention will be explained in further detail with reference to the drawing.

Figure 1 depicts by example a section of the cell structures of two superimposing mobile communication networks, for example a UMTS network and a GSM network.

The UMTS network comprises a multiplicity of radio cells 10-14 supplied with radio signals by a multiplicity of fixedly installed base stations 20, 23, 24. The GSM network similarly comprises a multiplicity of radio cells 1-7 supplied with radio signals by a multiplicity of fixedly installed base stations 20-22.

The UMTS and the GSM network have, for example, the place of location for base station 20 in common.

A mobile station 30 is located within UMTS cell 10 and is supplied with radio

signals by, for example, base station 24. The mobile station 30 intends to carry out a blind handover in a suitable radio cell of the GSM network.

According to the invention, for this purpose, first, the residence site of the mobile station 30 must be determined.

Through a suitable application, the terminal set is requested to measure the supply level and the quality of the base station 24 and of the neighboring UMTS base stations 20, 23. From the terminal set [sic] 30 the appropriate base stations 20, 23, 24 must herein be unambiguously identified and the associated propagation times of the signal at the air interface must be determined. This information of the neighboring cells and of the own cell are sent as an information packet to a base station, for example 24.

The place of location of the terminal set 30 can consequently be calculated in the UMTS network from only two measured neighboring cells and the own cell. This method does not depend on the residence site of the terminal set either within or outside of a building.

To determine the residence site of a subscriber terminal set without knowing the direction information, thus at least three base stations 20, 23, 24 are necessary, whose precise place of location is known. Based on the measurements of the propagation time of the signals between the terminal set and each of the base stations, circular rings can be calculated which define the distance range of the terminal set from the particular base station. In the center of each circular ring is located a base station. The common intersection point of the three circular rings is the residence site of the terminal set. The places of location of the base stations are herein reference points, the place of location coordinates being available from the place of location data base of the network operator.

In theory, the three circles intersect in one point. Under real conditions, this is impossible since the propagation time measuring principle must depend on the propagation conditions and the processing speed of the signals in the microchip

of the terminal set (chip frequency). The path segments per measuring interval cannot be arbitrarily small.

This means in practice that the residence sites of the terminal set is described by a surface of intersection. Therein the accuracy of the place of location determination increases with the number of measured base stations. Through a chip frequency of, for example, 3.84 Mhz, the smallest measuring interval a per chip can be calculated to be

$$a = \text{speed of light } C / \text{chip frequency } f_{\text{bit}} = 300 * 10^6 / 3.84 * 10^6 = 78 \text{ m}$$

With modern terminal sets in practice very much better measuring accuracies can be obtained.

The accuracy also depends on the receiver of the terminal set. The receiver must be able to resolve time intervals within the chip frequency in order to yield results in the 10 m range. The common surface of intersection of the circles indicates the probable area of the [temporary] residence of the terminal set.

Since the terminal set does not have any information about the frame synchronicity of the participating base stations, the determined residence site of the terminal set will have additional measuring errors.

To circumvent this, mainly two options are available:

- The base stations are synchronized via a central clock or via GPS time.
- Through measurements by the base stations the degree of asynchronicity with other base stations is determined and stored in a matrix.

Based on the determined residence site of the mobile station 30, the radio cell or base station of the GSM network best suited for a handover is determined with the aid of a data base available in the mobile communication network. In Figure 1 this is for example the GSM base station 20, which *inter alia* supplies the GSM radio cell 1.

In order for the mobile station 30 to complete an HO to the appropriate GSM target cell 1, it is necessary to inform it of the target cell or the appropriate base station 20, after the local information (measured values) of the terminal set has been evaluated. This can be carried out directly in the form of an HO command to the mobile station.

This leads to the fact that the functionality of the appropriate network node, for example RNC, must be expanded to the effect that the evaluation of the measurement data yields a local information, therefrom by a best server data base the best supplying base station of the target cell is determined and made available to the terminal set and the base stations participating in the handover.